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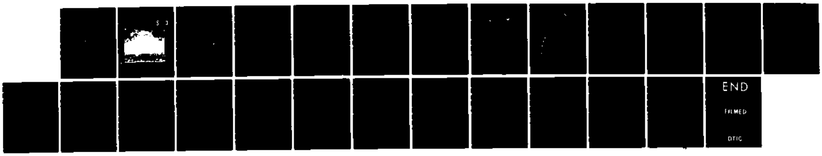

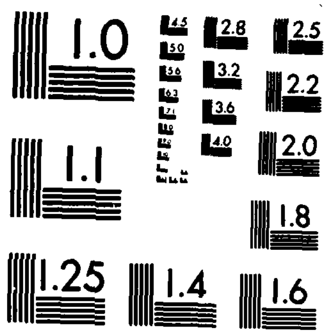

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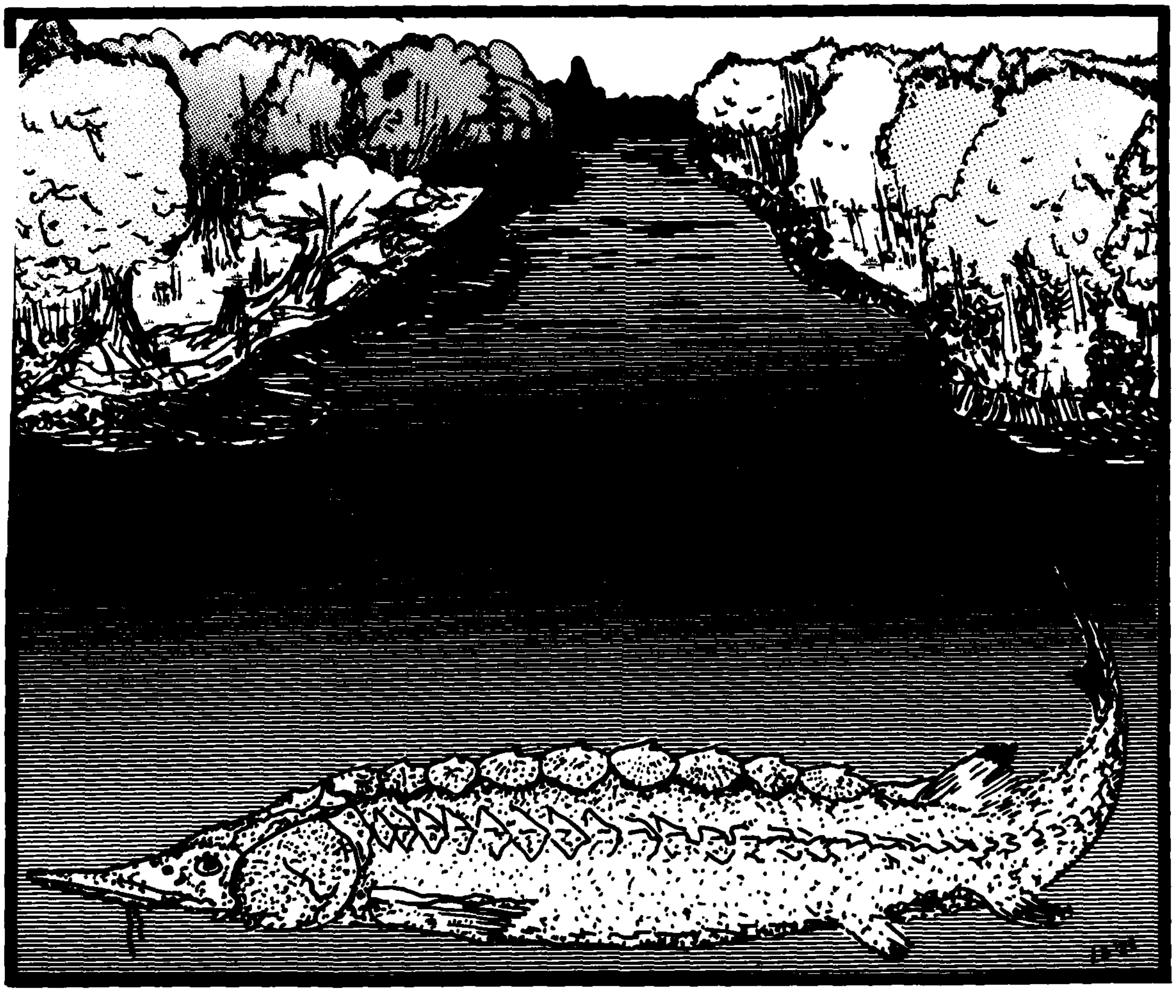
Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (South Atlantic)

ATLANTIC STURGEON



Fish and Wildlife Service
U.S. Department of the Interior

Coastal Ecology Group
Waterways Experiment Station
U.S. Army Corps of Engineers

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Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (South Atlantic)

ATLANTIC STURGEON

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Vicksburg, MS 39180

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Division of Biological Services
Research and Development
Fish and Wildlife Service
U. S. Department of the Interior
Washington, DC 20240

PREFACE

This species profile is one of a series on coastal aquatic organisms, principally fish, of sport, commercial, or ecological importance. The profiles are designed to provide coastal managers, engineers, and biologists with a brief comprehensive sketch of the biological characteristics and environmental requirements of the species and to describe how populations of the species may be expected to react to environmental changes caused by coastal development. Each profile has sections on taxonomy, life history, ecological role, environmental requirements, and economic importance, if applicable. A three-ring binder is used for this series so that new profiles can be added as they are prepared. This project is jointly planned and financed by the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service.

Suggestions or questions regarding this report should be directed to:

Information Transfer Specialist
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or

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CONVERSION FACTORS

Metric to U.S. Customary

Multiply	By	To Obtain
millimeters (mm)	0.03937	inches
centimeters (cm)	0.3937	inches
meters (m)	3.281	feet
kilometers (km)	0.6214	miles
square meters (m^2)	10.76	square feet
square kilometers (km^2)	0.3861	square miles
hectares (ha)	2.471	acres
liters (l)	0.2642	gallons
cubic meters (m^3)	35.31	cubic feet
cubic meters	0.0008110	acre-feet
milligrams (mg)	0.00003527	ounces
grams (g)	0.03527	ounces
kilograms (kg)	2.205	pounds
metric tons (t)	2205.0	pounds
metric tons	1.102	short tons
kilocalories (kcal)	3.968	British thermal units
Celsius degrees	1.8(C°) + 32	Fahrenheit degrees

U.S. Customary to Metric

Multiply	By	To Obtain
inches	25.40	millimeters
inches	2.54	centimeters
feet (ft)	0.3048	meters
fathoms	1.829	meters
miles (mi)	1.609	kilometers
nautical miles (nmi)	1.852	kilometers
square feet (ft^2)	0.0929	square meters
acres	0.4047	hectares
square miles (mi^2)	2.590	square kilometers
gallons (gal)	3.785	liters
cubic feet (ft^3)	0.02831	cubic meters
acre-feet	1233.0	cubic meters
ounces (oz)	28.35	grams
pounds (lb)	0.4536	kilograms
short tons (ton)	0.9072	metric tons
British thermal unit (BTU)	0.2520	kilocalories
Fahrenheit degrees	0.5556(F° - 32)	Celsius degrees

CONTENTS

ACKNOWLEDGMENTS

We are grateful for the reviews by Mr. Don Marchette, South Carolina Wildlife and Marine Resources Department, Charleston, and Mr. Jack Buckley, Massachusetts Cooperative Fishery Research Unit, Amherst.

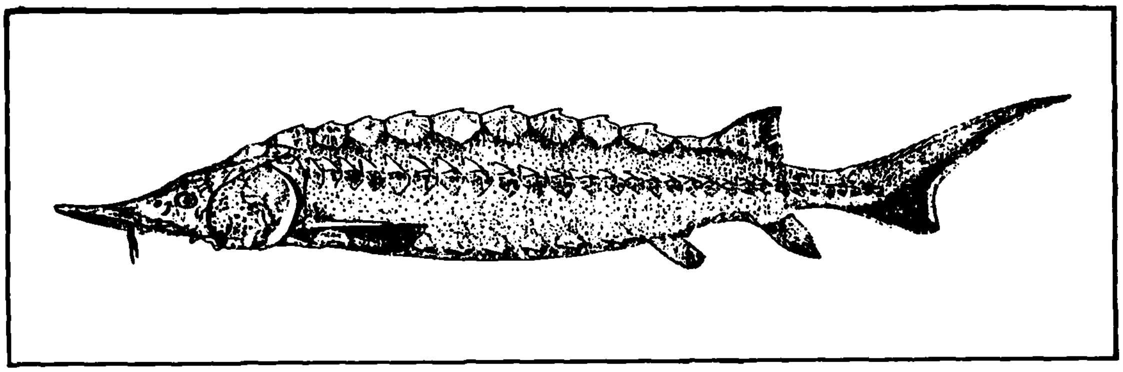

Figure 1. Atlantic sturgeon.

ATLANTIC STURGEON

NOMENCLATURE/TAXONOMY/RANGE

Scientific name . . . . . . *Acipenser oxyrhynchus oxyrhynchus*
Preferred common name . . . . Atlantic sturgeon (Figure 1)
Other common names . . . . . . Common sturgeon, sharp-nosed sturgeon, sea sturgeon, big sturgeon
Class . . . . Osteichthyes
Order . . . . Acipenseriformes
Family . . . . Acipenseridae

Geographic range: The Atlantic sturgeon inhabits the western North Atlantic in fresh-, brackish, and saltwater from Labrador and Newfoundland southward to the St. Johns River, Florida (Backus 1951; Vladykov and Greeley 1963). The gulf coast subspecies (*A. oxyrhyunchus desotoi*) inhabits rivers entering the Gulf of Mexico and southward to the Atlantic coast of Central and northern South America (Huff 1971)[1]. The species is anadromous, and major centers of abundance are associated with large rivers (Figure 2).

MORPHOLOGY/IDENTIFICATION AIDS

Material in this section is taken from Vladykov and Greeley (1963). The body is fusiform and has five rows of bony scutes: one dorsal, two lateral, and two ventral. Scutes are sharply pointed in young specimens, but become

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[1]The species *A. oxyrhynchus* Mitchill is presently regarded as having two subspecies: the Atlantic sturgeon and the gulf coast sturgeon (*A. oxyrhynchus desotoi*). This Species Profile emphasizes the Atlantic subspecies. Information for the Gulf of Mexico subspecies is included in sections where information on the Atlantic subspecies is inadequate.

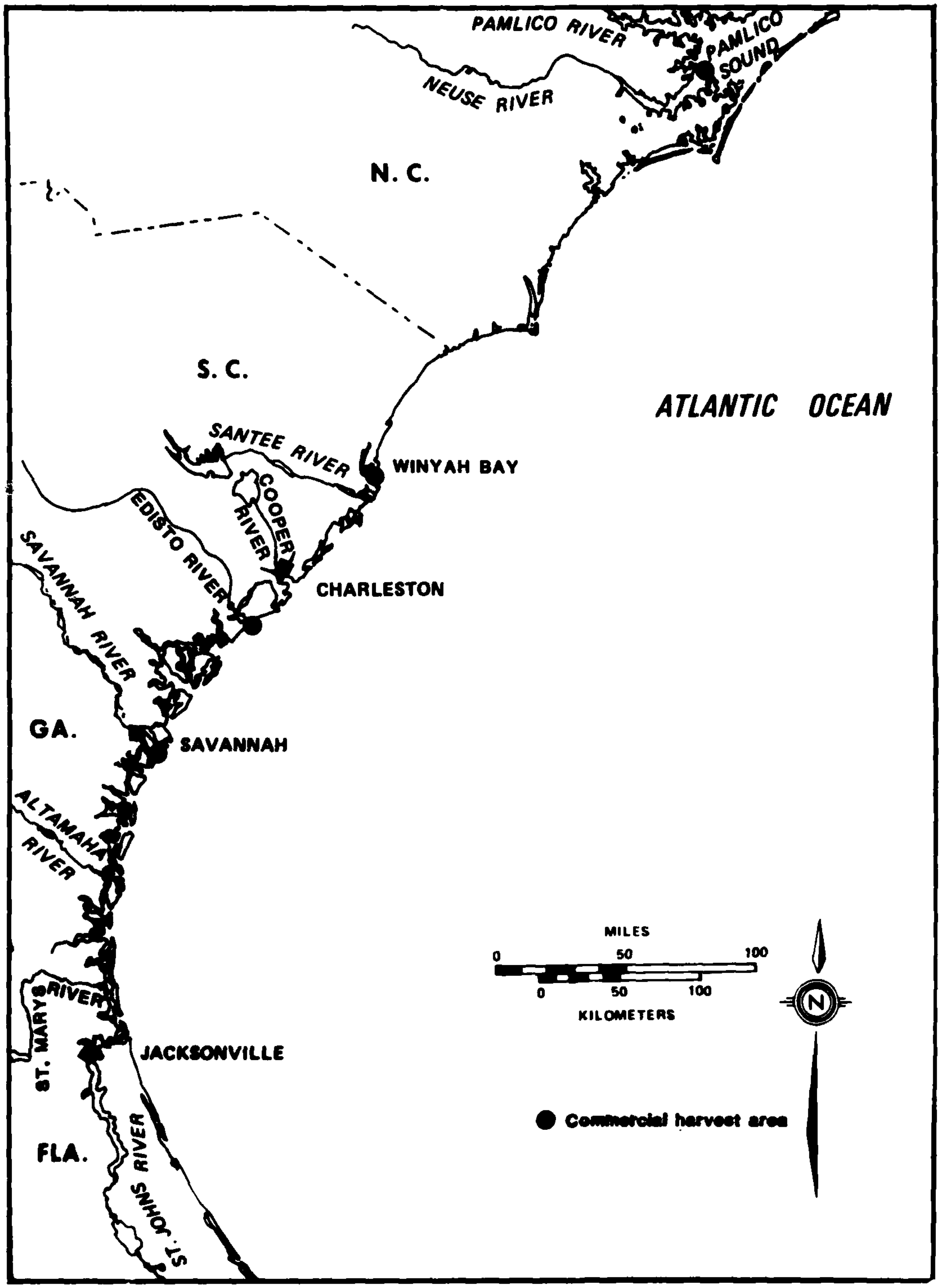

Figure 2. Major rivers supporting Atlantic sturgeon in the south Atlantic Region.

blunt or are absorbed with age. Snout is protruding and mouth is subterminal with four barbels in front. Mouth width is less than 55% of the interorbital width; the number of gill rakers is 17-27 (average 21.6); postdorsal and preanal shields occur in pairs. Appearance changes considerably with age or size: the snout becomes relatively shorter and blunter, the scutes become smoother, and the lower lobe of the caudal fin becomes relatively longer. Sexes are externally distinguishable only for mature individuals during the spawning season, when females have greatly swollen abdomens full of ripe eggs.

The Atlantic sturgeon is sympatric with the shortnose sturgeon (Acipenser brevirostris) throughout most of its range and with the lake sturgeon (Acipenser fulvescens) in parts of the St. Lawrence River and other northerly areas. Vladykov (1955) and Vladykov and Greeley (1963) provided keys for distinguishing the species. Relative to the shortnose sturgeon, the Atlantic sturgeon has a narrower mouth, fewer gill rakers, and greater maximum size. In the Atlantic sturgeon the scutes in front of the anal fin are paired (single row in shortnose) and the viscera are unpigmented or pale (blackish in shortnose). Vladykov and Greeley (1963) cautioned that many traits change with fish size and that distinguishing young specimens is extremely difficult.

Vladykov (1955) claimed subspecific status for the Atlantic and Gulf of Mexico sturgeons on the basis of differences in relative head length, spleen length, pectoral fin-ray length, and shape of the dorsal scutes. Vladykov's description of the gulf sturgeon, however, was based on only two specimens, and recent, comprehensive work has shown the groups to differ only according to relative spleen length (C. Wooley, personal communication, U.S. Fish and Wildlife Service, Office of Fishery Assistance, Panama City, Florida).

Some authors consider the Atlantic sturgeon of North America to be the same species as Acipenser sturio Linneaus of Europe, but this is not generally accepted at present (Magnin and Bealeiu 1963, cited by Murawski and Pacheco 1977). Vladykov and Greeley (1963) summarized differences between these species.

REASON FOR INCLUSION IN SERIES

The Atlantic sturgeon once supported significant commercial fisheries in rivers along the Atlantic seaboard of North America, but stocks have declined because of a combination of overfishing, deterioration of water quality, and damming of rivers. The species' slow rate of maturation and its use of estuaries, coastal bays, and upstream areas of rivers make Atlantic sturgeon stocks vulnerable to habitat alterations in many areas. Recently increased exploitation of mature females to produce caviar may add pressure on local populations.

LIFE HISTORY

Previous comprehensive reviews of Atlantic sturgeon biology include Vladykov and Greeley (1963), Huff (1975), Murawski and Pacheco (1977), and Rulifson and Huish (1982).

Spawning and Migrations

Atlantic sturgeon are anadromous: they spawn in freshwater rivers, and the young descend gradually to sea, where they grow and mature. No reports have been published about exact spawning locations, timing, and associated environmental conditions in rivers along the South Atlantic Bight; spawning periods can only be inferred from reported timing of spawning migrations. Migrations begin during February in South Carolina and the St. Marys River, Georgia (Smith et al.

1982), and during April in Chesapeake Bay (Smith 1907; Hildebrand and Schroeder 1928). Vladykov and Greeley (1963) indicated that spawning migrations begin progressively later at higher latitudes. In the Delaware River, migrations begin in late April, and Borodin (1925) suggested that sturgeon spawned at water temperatures of 13.3°-17.8° C. Adult sturgeon first appeared in the Winyah Bay system, South Carolina, during the second or third week of February in 1979, 1980, and 1982, when water temperatures were 7°-8° C (Smith et al. 1982). Huff (1975) reported that Gulf of Mexico sturgeon in the Suwannee River, Florida, began upriver migrations in February and spawned from March through early May.

Knowledge of spawning locations is based primarily on collections of ripe females in northern rivers. Borodin (1925) reported that sturgeon in the Delaware River apparently gathered for spawning in an upriver area where currents were strong and bottom substrates were hard clay. Spawning has been observed during late May and early June in downstream areas of the Pee Dee River, South Carolina, that are bordered by cypress/tupelo swamps (D. E. Marchette, personal communication, South Carolina Wildlife and Marine Resources Department, Marine Resources Research Institute, Charleston). The spawning sites are characterized by relatively low current velocities, turbid water, and sand and silt bottom substrates with an abundance of organic debris.

Available evidence indicates that eggs are broadcast into flowing water and become widespread after fertilization. Dees (1961) indicated that Atlantic sturgeon spawn in running brackish or freshwater as deep as 3 m over small rubble or gravel. Vladykov and Greeley (1963) speculated that Atlantic sturgeon spawn in pools below waterfalls of certain St. Lawrence River tributaries. No data on water temperature, salinity, current velocity, or dissolved oxygen concentrations associated with spawning are reported.

It is possible that spent fish return gradually to saltwater (Vladykov and Greeley 1963). Scott and Crossman (1973) reported that sturgeon migrated downstream from September through November in the St. Lawrence River; gulf sturgeon migrate downstream from October through December in Florida (Huff 1975).

Eggs and Larvae

Eggs are demersal and adhesive and occasionally occur in stringy clusters or ribbons (Murawski and Pacheco 1977). Eggs attach to weeds, stones, and other types of submerged structures (Vladykov and Greeley 1963). Huff (1975) attributed his failure to collect spawned sturgeon eggs in drift nets to their demersal, adhesive nature. Ripe (unfertilized) eggs are globular, light to dark brown, and 2.5-2.6 mm in diameter (Ryder 1890; Borodin 1925). Fertilized eggs are 2.0-2.9 mm in diameter, slate gray or light to dark brown, and are initially globular but become oval with development (Jones et al. 1978).

Jones et al. (1978) provided an illustrated summary of egg developmental stages originally reported by Dean (1893). Reported incubation periods are: within 94 hr at about 20° C (Dean 1895); 168 hr at 17.8° C (Vladykov and Greeley 1963); 92 hr at an unspecified temperature (Dean 1893); and 121-140 hr at about 18° C, 10 mg/l dissolved oxygen, and pH 7.0 (Smith et al. 1980). Effects of most environmental factors on incubation or egg survival are unknown.

Few data on fecundity are available. Smith et al. (1982) estimated fecundity for 11 females (48-104 kg total weight) from South Carolina. They calculated a linear relationship of the number of eggs (Y) versus body weight (X, in kg) to be: Y = 233,064

+ 13,307 X (r = 0.84). Females in the Delaware River contained 800,000-2,400,000 eggs (Ryder 1890), and North Carolina females contained 1 million to 2.5 million eggs (Smith 1907). Vladykov and Greeley (1963) reported a fecundity range of 1.0 million for a 75-kg female to 3.8 million for a 160-kg specimen.

No information is available regarding larval life history. Yolk-sac larvae were described by Ryder (1890), who reported newly hatched fry to be 11 mm long. Smith et al. (1980) described hatchery-reared larvae; sac fry averaged 7.1 mm in length and 4 mg wet weight. Larvae doubled in length after 15 days and reached 15 mm in length and 4.6 g in weight by 131 days of age.

Juveniles and Adults

Most information on juveniles is based on collections of rather large specimens taken by gillnetting, trawling, or incidentally in commercial gear. Accuracy of some published information has been questioned because shortnose sturgeon, which rarely exceed 100 cm in total length (Vladykov and Greeley 1963), may have been misidentified and included as juvenile Atlantic sturgeon. Smith et al. (1982) captured young-of-the-year sturgeon from nursery areas in the Edisto and Waccamaw Rivers, South Carolina. The nursery areas were broad reaches of the rivers in downstream, tidally influenced transition zones having hard sand or shale substrates. Salinities in these areas ranged from 1 to 5 parts per thousand (ppt) in the Edisto River and from 0 to 3 ppt in the Waccamaw River. Atlantic sturgeon retain juvenile characteristics up to 122 cm fork length (FL) and the young may spend several years in freshwater before migrating to sea (Murawski and Pacheco 1977). Fischer (1980) captured 34- to 77-cm FL immature sturgeon emigrating from the Cape Fear River in 1975 and one 60.5-cm FL immature specimen in 1979. Vladykov and Greeley (1963) indicated that some tagged immature fish remained in fresh- and brackish waters of the St. Lawrence River while others moved several hundred kilometers from their points of release. Recaptures of tagged fish indicated movements toward freshwater in spring and back to saltwater in the fall.

Holland and Yelverton (1973) summarized recapture information for juvenile sturgeon tagged along the North Carolina coast. Several recaptures were made in adjacent sounds and inlets, indicating no absolute affinity by the fish for the system in which they were originally tagged. Recaptured fish tended to move southward along the coast during November through January and northward during late winter and early spring. One 9.5-kg individual moved 645 km northward to Long Island in 65 d

Smith et al. (2) conducted intensive netting to study juvenile migrations and distribut o in the following three regions of the Winyah Bay system, South Carolina: (1) tidally influenced brackish to high-salinity areas in the ocean-estuary zone; (2) tidally influenced freshwater areas in upper estuaries and lower rivers; and (3) strictly freshwater riverine areas with no tidal influence. They concluded that juvenile sturgeon generally occupied tidally influenced freshwater areas during warmer months and moved to brackish estuaries during colder periods.

Smith et al. (1982) tagged 35 juvenile sturgeon (38-78 cm fork length) in South Carolina and reported six recaptures. One tagged in the Edisto River moved about 600 km northward to Pamlico Sound, North Carolina, in 326 days; one tagged in Winyah Bay traveled about 2,100 km in 80 days to Chesapeake Bay; and four were recaptured within 60 km of their tagging sites in Winyah Bay.

Vladykov and Greeley (1963) summarized published reports about sturgeon in Hudson River, Chesapeake Bay, and the Delaware River. They concluded that immature sturgeon up to 8 years of age and 100 cm in length lived in upstream freshwater areas, downstream estuaries, and nearby saltwater areas throughout most of the year. They also concluded, however, that sooner or later immature sturgeon probably move out to sea where growth is greatly accelerated. Huff (1975) suggested that juvenile Gulf of Mexico sturgeon participated in pre- and postspawning migrations in the Suwannee River even though they were immature. Juveniles have been reported to range to a maximum depth of about 20 m (Vladykov and Greeley 1963).

Age and size at maturity vary with gender and locality. Vladykov and Greeley (1963) concluded that females are not mature until they weigh at least 68 kg and are 10 years old. The smallest ripe male they encountered in the St. Lawrence River was 175 cm long and weighed 32 kg. In South Carolina, males first spawned at 5-13 years of age, and females first spawned at 7-19 years of age (Smith et al. 1982). In the Suwannee River, Florida, female Gulf of Mexico sturgeon were sexually differentiated as young as age VIII, but some remained immature until age XII; corresponding ages for males were VII and X (Huff 1975). Sexes began to differentiate at 50-70 cm in length; the youngest ripe specimens were age XII (female) and IX (male). Huff (1975) speculated that spawning may be delayed for 1 or 2 years after maturity is reached (as has been reported for the lake sturgeon [Roussow 1957]). Vladykov and Greeley (1963) suggested that some females spawn only once every 2 or 3 years. Smith et al. (1982) also noted periodic spawning for sturgeon from South Carolina. On the average, 4.5 and 1.6 years elapsed between the first and second and the second and third spawnings for males while 5.4 and 3.5 years elapsed between these spawns for females.

Available information on distribution patterns of adults mainly relates to fish collected during spawning migrations (as summarized above). Distribution in saltwater is known only from occasional catches of adults incidental to commercial netting in the North Atlantic Bight. Vladykov and Greeley (1963) reported that most are caught in coastal areas, but some are taken from shelf waters and offshore fishing grounds at depths down to 50 m.

Longevity and Mortality

Longevity may vary with latitude (Murawski and Pacheco 1977), but no estimates of average life expectancy have been made. Reported maximum ages (generally meaning the oldest specimens collected) are about 42 years for the Gulf of Mexico sturgeon in the Suwannee River, Florida (Huff 1975); over 12 in the Hudson River (Greeley 1937); and 60 in the St. Lawrence River (Magnin 1964, cited by Murawski and Pacheco 1977). Ages IV through XVII were regularly represented in Huff's (1975) collections from the Suwannee River. In South Carolina, the commercial catch included sturgeon that were 5 to 30 years old and research collections included specimens up to 4 years of age (Marchette et al., unpublished MS[2]).

Mortality estimates are published only for the Gulf of Mexico subspecies in the Suwannee River. The average

[2]Age-growth, maturity, and mortality of the Atlantic sturgeon, Acipenser oxyrhynchus (Mitchill) in South Carolina. Marchette, D. E., R. A. Smiley, and T. I. J. Smith, South Carolina Wildlife and Marine Resources Department, Marine Resources Research Institute, Charleston, SC 29412.

annual survivorship computed for ages VIII through XII was 53.7% (Huff 1975).

There are no data adequate for determining effects of environmental factors on recruitment. The long period required to reach maturity, possibly irregular spawning periodicity after maturity is reached, and prolonged reliance on river systems make juvenile and adult sturgeon highly susceptible to habitat alterations, pollution, and overexploitation.

GROWTH CHARACTERISTICS

Growth data for hatchery-reared larvae and juveniles are summarized in Table 1. Little is known about growth of young in natural settings. Scott and Crossman (1973) considered specimens collected from the St. Lawrence River in August at 6.5-11 cm long and 0.7-4.2 g in weight to be less than 1 year old. Fish collected in October of the same year ranged from 13 to 20 cm in length and from 7 to 48 g in weight.

Atlantic sturgeon have been aged from growth rings on otoliths and ossified rays from pectoral fins (Vladykov and Greeley 1963). Although growth rings have been assumed to correspond to annual marks, studies validating this assumption for Atlantic sturgeon have not been reported. Huff (1975) reviewed the literature dealing with aging of sturgeons (including papers by Cuerrier 1951; Probst and Cooper 1954; Pycha 1956; Roussow 1957; and Priegel and Wirth 1971) and chose to use fin ray sections in his project. Huff determined ages of 17 Gulf of Mexico sturgeon by operculi and fin rays and found that ages from fin rays averaged 3.1 years (range of 2-7 years) older than ages determined from operculi. He concluded that annual marks on operculi became obscured with age. Huff was unable, however, to use the spacing of annuli on fin rays to back calculate length-at-age because of problems related to ray morphology and the position and angle at which the fin rays were sectioned. Smith et al. (1982) used pectoral fin ray sections to age sturgeon in South Carolina, and Marchette et al. (unpublished MS[2]) used fin ray sections to back calculate lengths of 160 specimens.

Table 1. Growth of cultured Atlantic sturgeon (from Smith et al. 1980).

Age (days)	Mean length (mm)	Mean weight (mg)
1	7.1	4
2	8.8	5
11	12.8	8
15	13.7	25
19	18.0	33
20	19.9	46
71	81.7	1,970
130	102.8	3,111
131	115.2	4,646

Published size-at-age data for Atlantic sturgeon are summarized in Table 2. Relationships between fork length and total length, fork length and age, and weight and length are summarized in Table 3. Carlander (1969) also summarized weight-length relationships.

The maximum size of Atlantic sturgeon has been the subject of much speculation. Ryder (1890) found that females averaged about 244 cm total length (TL) and sometimes reached 305 cm, whereas males ranged from 183 to 213 cm. Vladykov and Greeley (1963) gave accounts of several notable specimens, including one 427-cm female weighing 368 kg from the St. John River, New Brunswick. The largest individuals tend to be females (Scott and Crossman 1973).

Table 2. Average fork length (FL in cm) observed at age for the Atlantic sturgeon (sexes combined).

Age (years)	Locality				
	St. John River New Brunswick[a]	St. Lawrence River[b]	Hudson River[c]	South Carolina[d]	Suwannee River[e]
1	36	20	26	44	35
2	47	25	41	50	51
3	52	31	54	55	64
4	63	37	59	61	75
5	96	44	57	109	83
6	97	51	63		106
7	101	58	73	138	110
8	109	66		143	118
9	108	76	165	149	123
10	101	79	166	152	127
11	112	86	208	162	132
12		92		163	147
13		96		170	136
14		101		182	158
15		105		182	155
16	130			186	135
17				193	149
18				196	
19				202	
20		141		198	
21				195	
22				201	
23				203	
24				199	
25				211	
46		226			
60		232			

[a]Murawski and Pacheco (1977) reported these data and cited M. Dadswell, pers. comm.
[b]Magnin (1964) reported total lengths; data were converted to FL by Murawski and Pacheco (1977) using a relationship from Magnin (1964).
[c]Greeley (1937) reported total lengths; Murawski and Pacheco (1977) converted to FL as in footnote b.
[d]Smith et al. (1982).
[e]Huff (1975).

THE FISHERY

No significant sport fishery for the Atlantic sturgeon exists, but some are taken incidentally to other species; a few localized fisheries, using techniques such as snagging below dams, have developed (e.g., Burgess 1963, cited by Huff 1975). There is, however, a long history of commercial exploitation in North America. Records indicate use by

Table 3. Relationships between measures of body size and age for Atlantic sturgeon.

Relationship	Equation	Location	Source
Fork length (FL) vs. total length (TL)	$FL = 0.867\ TL + 10$ (FL and TL in mm)	St. Lawrence River	Magnin (1962)[a]
Weight (W) vs. total length	$W = (1.14 \times 10^{-6})\ TL^{3.18}$ (W in Kg, TL in cm)	St. Lawrence River	Magnin (1962)[a]
Fork length vs. age	$FL = 36.9233\ AGE^{0.5284}$	Suwannee River	Huff (1975)[b]
	$FL = 3.91 + 117.98\ (AGE)$ (FL in cm, AGE in years)	South Carolina	Smith et al. (1982)[c]
Weight vs. fork length			
Sexes combined	$W = (1.1471 \times 10^{-5})\ FL^{2.924}$	Suwannee River	Huff (1975)[b]
Males only	$W - (2.8667 \times 10^{-4})\ FL^{2.297}$	Suwannee River	Huff (1975)[b]
Sexes combined	$W = (5.46 \times 10^{-6})\ FL^{3.10}$ (W in kg, FL in cm)	North Carolina	Holland and Yelverton (1973)

[a] As cited by Murawski and Pacheco (1977).
[b] Gulf of Mexico subspecies; relationships valid for fish 1 - 17 years of age.
[c] Relationship valid for fish 7 - 25 years of age.

aboriginal Americans (Ritchie 1969) and commercial exploitation in the 17th century to support an export industry to Europe (see Murawski and Pacheco 1977 for additional accounts of historical fisheries).

The history of effort, harvest methods, landings, and value of the catch have been summarized by Murawski and Pacheco (1977) for most of the Atlantic seaboard and the Gulf of Mexico and by Rulifson and Huish (1982) for the South Atlantic Bight and the Gulf of Mexico. Most of the following information is taken from these summaries.

Catch

Commercial landings from the Atlantic seaboard and the Gulf of Mexico declined drastically in the late 19th century, remained relatively low in most areas through World War II, and increased somewhat thereafter. The major fisheries were in New Jersey, Pennsylvania, and Delaware; these crashed in about 1900 and landings now are only about 1% of former levels. Landings in the South Atlantic Bight also fell at the turn of the century, but the region now provides the majority of the United States harvest.

Murawski and Pacheco (1977) indicated that much of the present Atlantic sturgeon catch is incidental to fisheries directed to other species such as shad or striped bass; hence, data on effort are not available. Since 1965, catches from North and South Carolina have contributed 70%-75% of total eastern seaboard landings of sturgeon; catches from Georgia and the east coast of Florida have been relatively minor (Table 4).

Table 4. Harvest of sturgeon[a] from States along the South Atlantic Bight in thousands of pounds and value in thousands of dollars.

Year	North Carolina		South Carolina		Georgia		Florida (east coast)	
	Harvest	Value	Harvest	Value	Harvest	Value	Harvest	Value
1939	1	<1	0	0	6	1	17	2
1940	1	<1	3	<1	5	1	3	1
1945	1	<1	36	14	5	1	7	2
1950	11	3	17	4	15	5	0	0
1951	4	1	16	4	5	<1	0	0
1952	15	4	24	7	7	2	0	0
1953	15	4	22	4	25	5	0	0
1954	10	2	9	2	21	4	0	0
1955	2	<1	67	13	8	3	1	<1
1956	12	2	80	16	37	10	0	1
1957	16	2	45	9	12	2	1	<1
1958	22	3	35	7	4	1	0	0
1959	19	3	33	5	4	1	1	<1
1960	23	4	42	7	7	2	0	0
1961	40	6	51	9	4	1	0	0
1962	49	7	40	6	2	<1	1	<1
1963	43	9	53	8	3	1	0	0
1964	34	7	64	10	2	<1	0	0
1965	77	15	50	8	3	1	0	0
1966	59	8	43	8	1	<1	0	0
1967	38	5	33	6	1	<1	0	0
1968	47	7	44	8	1	<1	0	0
1969	132	14	40	7	1	<1	0	0
1970	120	19	6	1	4	1	0	0
1971	78	13	77	15	4	2	0	0
1972	154	31	68	18	8	2	0	0
1973	56	10	45	13	3	1	1	<1
1974	93	16	47	20	2	<1	0	0
1975	44	8	67	23	2	<1	0	0
1976	46	10	88	26	1	<1	0	0
1977	30	5	115	26	3	1	<1	<1
1978	32	7	94	31	11	3	<1	<1

[a]Data prior to 1973 include catches of shortnose sturgeon (Murawski and Pacheco 1977). Data for 1939-1975 from summary by Rulifson and Huish (1978). Data for 1976-1978 are from National Marine Fisheries Service (1978a, 1978b, 1978c, 1979a, 1979b, 1980a, 1980b, 1980c, 1981).

Sturgeon harvest presently is a minor component of total commercial finfish value in the South Atlantic Bight. Data summarized by Rulifson and Huish (1982) showed that the dockside value of sturgeon in the total commercial finfish harvest has been less than about 0.5% annually in North Carolina, 4.0% in South Carolina, 0.8% in Georgia, and 0.01% along the east coast of Florida.

Gear

Various gears have been used to harvest sturgeon, including traps, pound-nets, drift (gill) nets, trammel nets, otter trawls, harpoons, and seines. The major technique currently used in the South Atlantic Bight is gill netting in rivers and coastal areas (Rulifson and Huish 1982). Commercial gear is regulated to some extent in most States by requiring a license for each net (e.g., South Carolina; Smith 1979) or mesh size restrictions, as described in the Management section.

Stock Abundance

Catch data provide the only available index of population abundance; trends in landings suggest that major declines in stock size during the late 1800's were due to a combination of overfishing, pollution, and dam construction. Murawski and Pacheco (1977) summarized other publications describing declines in Atlantic sturgeon abundance. Smith (1907) stated that changes in habitat, overfishing, and destruction of young sturgeon caught by shad fishermen and other commercial operators were responsible for declines in North Carolina. Remaining North Carolina fishing areas include the Nuese River drift-net fishery, a trawl fishery in the ocean north of Cape Hatteras, and gill-net fisheries in Bogue Inlet, Bear Inlet, and Pamlico and Albemarle Sounds (Rulifson and Huish 1982).

Leland (1968) reviewed the history of sturgeon stocks in South Carolina and stated that mill dams and water supply dams blocked fish passage on many systems, limiting sturgeon to lowland sections of the rivers. The coincidence of shad and sturgeon fishing seasons and the kill of young sturgeon by shad fishermen could be a major factor in the decline of sturgeon populations (Leland 1968). Remaining South Carolina sturgeon fisheries included (in 1968) offshore netting near the mouth of Winyah Bay (which includes the Waccamaw, Back, PeeDee, and Sampit Rivers) and drift- or gill-netting in the Santee, Cooper, Edisto, and Savannah Rivers.

Remaining sturgeon stocks in Georgia and Florida are small and fisheries operate in limited areas within the Savannah, Altamaha, Ogeechee, and St. Marys Rivers (Rulifson and Huish 1982). A survey of Georgia coastal waters during 1970-73 (Mahood et al. 1974a, 1974b, 1974c, 1974d) indicated low numbers of sturgeon in Ossabaw, Doboy, St. Andrews, and Sapelo Sounds. Williams and Grey (1975, cited by Rulifson and Huish 1982) reported that there presently is no sturgeon population in the St. Johns River, Florida, but that sturgeon are occasionally captured incidentally to a shad fishery in the St. Lucie River, Florida.

Management

Previous management of Atlantic sturgeon has included gear restrictions, closed seasons, minimum size limits, and closed areas. Rulifson and Huish (1982) reported the following methods for protecting and managing the species in the Southeastern United States. South Carolina fishermen must purchase a license for each net (minimum net size is 10 inches stretch mesh) and submit monthly catch reports; the season is open March 1 to October 1 (Smith 1979). South Carolina dealers are required to purchase a processing and marketing license. In Georgia, the sturgeon season generally is January to July (subject to legislative change annually), and the minimum bar-mesh size is 6 inches. The minimum legal mesh size in Florida is 10-inch stretch measure. North Carolina has no management program or regulations regarding sturgeon.

Culturing young sturgeon for stocking in natural habitats was attempted in the late 1800's (Ryder 1890; Cobb 1900), but development of techniques suffered because of problems with simultaneously obtaining ripe males and females. The presence of reproductively inactive or sexually immature sturgeon in spawning runs often led to collection and sacrifice of many specimens before suitable ripe pairs were obtained. This practice may have caused greater losses than the gains resulting from subsequent stocking.

Smith et al. (1980) reported the only successful artificially induced spawning of Atlantic sturgeon. Rulifson and Huish (1982) suggested that culture of juveniles and holding of brood stock in ponds may be feasible.

The shortnose sturgeon is protected by the Endangered Species Act and cannot be taken legally. This may offer some protection for the Atlantic sturgeon since they resemble shortnose sturgeon of the same size.

ECOLOGICAL ROLE

Feeding

No reports of sturgeon food habits in the South Atlantic Bight were located. The limited amount of information published from other areas, however, suggests that sturgeon are opportunistic feeders and will likely consume whatever types of bottom-dwelling organisms are present. In the sea, large sturgeon feed on mollusks and other bottom organisms. Ryder (1890) stated that sturgeons root in the sand or mud with their snouts, using their barbels as organs of touch, and draw the substrate and organisms it contains into their mouths. Bigelow and Schroeder (1953) reported that sturgeon ate mollusks, polychaete worms, gastropods, shrimps, isopods, amphipods, and small bottom-dwelling fishes such as launce (*Ammodytes* spp.). Adults apparently do not eat while migrating upstream to spawn (Scott and Crossman 1973).

Vladykov and Greeley (1963) reported that "half-grown" sturgeon taken in saltwater ate polychaete worms, gastropods, shrimps, amphipods, and isopods. Sturgeon they collected from freshwater areas of the St. Lawrence River, however, ate aquatic insects, amphipods, oligochaete worms, and larvae of the burrowing mayfly (*Hexagenia*).

Huff (1975) noted that Gulf of Mexico sturgeon collected in one area of the Suwannee River contained partially digested fibrous vegetation and occasional crab hard parts. Huff believed the fragments to be from blue crabs (*Callinectes sapidus*); their relative importance in the diet was not quantified. Stomach contents in another Suwannee River area were primarily gammarid amphipods typically associated with substrates similar to the submerged tidal sand bank where the sturgeon were collected (Huff 1975).

Prey use by larvae or age 0 sturgeon from natural settings has not been described. Smith et al. (1980) fed hatchery reared sac-fry a variety of foods, including live brine shrimp (*Artemia*) nauplii, beef liver puree mixed with salmon mash, freeze-dried *Daphnia*, squid pellets, and assorted tropical fish flakes. After yolk sacs were absorbed, the beef liver and salmon mash mixture and live *Artemia* were used as food. After the young were 54 days old, a salmon mash diet was used, but the omission of beef liver apparently stressed the fish, and the diet was again supplemented with liver.

Competition and Other Ecological Interactions

Very little is documented regarding competitors or predators of the sturgeon. Many species of fish inhabit the same rivers and estuaries occupied by the Atlantic sturgeon, and there is a potential for competition with bottom-dwelling species and for predation on early life stages. The apparent nonselective feeding of juvenile and adult sturgeons may reduce the potential for competition with other species.

The large size and armor of juveniles and adults preclude predation by most fishes. Scott and Crossman (1973) stated that sturgeon are attacked and sometimes killed by lampreys (*Petromyzon marinus*).

No accounts of Atlantic sturgeon parasites or diseases in the South Atlantic Bight were located. Appy and Dadswell (1978) found five species of helminth parasites and one parasitic arthropod in Atlantic sturgeon from the St. John River, New Brunswick. The two mature sturgeon collected were infested with marine parasites and two of four juveniles were infested with one species of freshwater parasite. Infestation by some parasites was attributed to their presence in snails, which served as intermediate hosts, consumed by the sturgeon. Appy and Dadswell (1978) concluded that differences in the parasites of Atlantic and shortnose sturgeon indicated that the host species had different distributions in the river system they studied. Murawski and Pacheco (1977) reported that the trematode *Deropristis hispida* has been found in Atlantic sturgeon taken from Raritan Bay, New Jersey.

ENVIRONMENTAL REQUIREMENTS

Although declines in sturgeon stocks have been attributed, in part, to construction of barriers across rivers and to pollution, there is essentially no quantitative information on responses of Atlantic sturgeon to thermal, chemical, or flow-related conditions. Problems associated with the species' large size and the unavailability of small juveniles have precluded laboratory evaluations of the effects of temperature, salinity, dissolved oxygen concentrations, etc.

The sturgeon's mode of feeding reflects an adaptation to gathering food from relatively soft-bottom substrates. The demersal, adhesive nature of the eggs suggests the need for minimum flow velocities of oxygenated water, low levels of suspended solids during incubation, and relatively hard-bottom substrates in spawning areas (such as clay, rubble or gravel, as reported by Vladykov and Greeley 1963).

Vladykov and Greeley (1963) stated that advanced juveniles of the Atlantic sturgeon had a remarkable capability for making rapid transitions between fresh- and saltwater, but nothing is reported about salinity tolerances for early life stages. Vladykov and Greeley (1963) stated that adults spawn in both fresh- and brackish waters and possibly prefer brackish areas. Other authors, however, have attributed stock declines to construction of dams that bar access to upstream spawning grounds (see Murawski and Pacheco 1977), suggesting that access to upriver freshwater areas is essential.

Concentrations of PCB's that generally exceeded Food and Drug Administration guidelines for human consumption were reported in sturgeon from the St. Lawrence and Hudson Rivers (Murawski and Pacheco 1977). Effects of PCB's or other contaminants on sturgeon have not been evaluated.

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16. Abstract (Limit: 200 words)
Species profiles are literature summaries of taxonomy, life history, and environmental requirements of coastal fishes and aquatic invertebrates. They are prepared to assist with impact assessment. The Atlantic sturgeon, Acipenser oxyrhynchus oxyrhynchus, is an anadromous species that occupies rivers, estuaries, and nearshore waters along the entire Atlantic coast of the United States. The species once supported significant commercial fisheries throughout its range, but stocks have declined because of overfishing, deterioration of water quality, and damming of rivers. Atlantic sturgeon spawn in rivers and the young remain in freshwater for several years prior to emigration to the ocean. Little is known about spawning areas and associated environmental factors. Females typically do not mature until age X and the age at first spawning ranges from 5 to 13 years for males and 7 to 19 years for females. Longevity may frequently exceed 25 years. Immature and adult sturgeons are bottom feeders and consume a variety of mollusks, crustaceans, worms, and other small bottom-dwelling invertebrates and fishes. Little is known about competitors, predators, or effects of environmental factors on recruitment. The long period required to reach maturity, possbily irregular spawning thereafter, and prolonged reliance on river systems make juvenile and adult Atlantic sturgeon highly susceptible to habitat alterations, pollution, and overexploitation.

17. Document Analysis a. Descriptors
Anadromous fishes
Migration
Spawning
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b. Identifiers/Open-Ended Terms
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